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SPONTANEOUS COMBUSTION,

BY

JOSEPH JONES M. D.

We begin, in this issue, the publication of a paper, prepared by Dr. Joseph Jones, of New Orleans, for an insurance company in this city, at the time of the Kieffer fire in 1874, on the subject of SPONTANEOUS COMBUSTION.

This document is not only a scientific production, but contains a large store of information, valuable to insurance companies and merchants; also to persons engaged in maritime affairs.

Results of Careful Inspection, Examination and Chemical Analysis of Materials Taken Out of the Closet on the Second Floor of the Building 91 Common street, Occupied by Kiefier Brothers.

BY JOSEPH JONES, M. D.,

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At the request of Mr. John Youenes, in behalf of the Board of Underwriters, I visited the premises, occupied by Kieffer Brothers, 91 Common street, and inspected the closet in which the fire occurred, and also examined carefully the articles lying around, which were partially burned. Mr. Youenes had also placed in a bag certain articles which were supposed to have caused the fire by spontaneous combustion.

I found in the closet burnt and unburnt paper, damaged by water.

The paper was *free* from all extraneous matter as oils, fixed or essential. The water had simply caused the writing ink to spread over the surface of the paper.

I also observed in the closet a partially burned woolen shirt or jacket, which by my direction was placed in the bag above mentioned.

Mr. Youenes secured the bag and caused it to be delivered to me, at my office and laboratory, corner Common and Baronne streets, up stairs, Nos. 3 and 5.

The bag contained the following articles:

1. Burnt and unburnt paper.
2. Charred matting.
3. Partially burned woolen jacket, such as business men frequently wear.
4. Bottles.
5. Tin cup of capacity of about half-gallon.
6. Tin can of capacity of about half-gallon.
7. 1 package of six scrubbing brushes. The scrubbing brushes were wrapped up in brown paper.

The following are the results of the chemical examination of the preceding articles:

1. *The burnt and unburnt paper* was entirely free from any oleaginous matter. The paper (old accounts, checks, etc.,) contained absolutely nothing besides ink and water.

2. *Charred Matting.*—The charred matting was carefully subjected to the action of such agents as chloroform, sulphuric ether and alcohol, in order that any oleaginous matter might be detected. The result of the analysis was that the charred matting was entirely free from any fixed or essential oils.

3. *Woolen Jacket or Shirt.*—The woolen jacket was carefully cut into small particles and subjected to the action of chloroform, ether and alcohol, in the displacement apparatus. The filtrates thus obtained were allowed to evaporate spontaneously and slowly.

It was clearly demonstrated by the preceding method that the woolen garment contained only such minute quantities of oil as are always present in all articles manufactured from wool. From the entire shirt I was unable to extract more than what was equivalent to five drops of oil.

4. *Bottles*—Two of the bottles *contained ink.* One bottle was empty, and appeared to have contained champagne; one bottle, also empty, appeared to have contained some preparation for the hair, most probably *Bay Rum.*

1. The fifth bottle contained a small quantity of varnish, just sufficient to cover the bottom.

5. *Tin cup of capacity of half gallon.*

This vessel contained a little dry black varnish at the bottom. It was otherwise entirely empty. The varnish gave no evidence of having been acted upon by fire. The small quantity of varnish in this cup and in the bottle was composed of a mixture of asphalt, gum shellac and some oleaginous solvent. The varnish was hard, and incapable of saturating cotton or wool It had no power whatever of producing spontaneous combustion.

6. *Tin can, of the capacity of about one gallon.*

I made a section of the tin can so as to expose its contents completely. The bottom of the can was covered to the depth of about two inches by semi solid black varnish. The varnish amounted to about one quart. The varnish being semi solid it could not be poured, and it was necessary to cut it with a knife. The varnish was softer at the bottom than towards the upper or free surface, which indicated that the can had not been overturned, but had remained in the upright position, and that its contents could not have been poured out.

The upper or free surface of the varnish in the can was parallel with the surface of the floor, which still farther confirms the preceding statement.

The sides of the can bore marks of fire, as if it had been kindled around the can, and especially around the upper portion. A portion of the varnish appeared to have been volatilized by the heat and projected from the mouth of the can and caused to run down the sides.

The varnish was composed of asphalt, gum-shellac, rosin and oleaginous matter employed as a solvent.

The black varnish was easily and entirely soluble in chloroform, ether and alcohol.

The black color was due to asphalt and not to finely divided carbon. When dissolved in chloroform, ether or alcohol, it passed readily and entirely through a a fine filter, and if there had been any finely divided carbon it could not have thus passed. The black varnish required a high heat to cause its combustion; that is, a heat of more than one thousand degrees (1000° F). When spread upon any surface the varnish rapidly dried. Cotton and wool saturated with this varnish showed not the slightest change of temperature, and the varnish rapidly assumed the solid condition.

This varnish possessed no properties whatever capable of producing spontaneous combustion; on the contrary, it was antiseptic and preservative in character, and tended to arrest those chemical changes, and more especially the oxidation of organic matters in which spontaneous combustion may originate

7. One package containing six (6) scrubbing brushes wrapped up in brown paper. This package was examined carefully, with the following results:

A. The outer layer of paper had a small quantity of varnish, which apparently had been projected by the heat during the fire upon the bundle, and at one point the paper was slightly charred and showed the effects of heat, fire and water.

Upon analysis I found the small spots of varnish upon the outer portion of the bundle to be identical in composition with that on the exterior and within the tin can.

The six scrubbing brushes were entirely free from any extraneous matter, and only two of them were slightly scorched; the other four resembled perfectly new brushes. The inner wrappings were clean and free from all oleaginous or extraneous matters.

The following is an outline and condensed statement of the method and results of the entire examination:

I discovered nothing during the entire examination of the contents of the building No. 91 Common street, which would indicate in any manner that the fire originated from spontaneous combustion.

Testimony to the above effect was delivered before Judge John L. Laresche, Third Justice of the Peace.

At the request of Mr. John Youenes, in behalf of the Board of Underwriters, I have consolidated and drawn up from the highest recognized authorities the following concise statement of the established facts and received views relating to *spontaneous combustion.*

ORGANIC STBSTANCES.

The most important questions on *spontaneous combustion*, have arisen in reference to *organic substances*, chiefly of *vegetable* origin.

It is well known that accidents occur from the admixture of strong *nitric* or *sulphuric acid* with *straw, wool*, or certain *essential oils.*

The effects in such cases, if any, are immediate, and create no difficulty.

Certain substances, without contact with any chemical agents—such as *hay, cotton* and *woody fibre*, including *tow, flax, hemp, jute, rags, leaves, spent tan, cocoanut fibre, straw in manure heaps*, etc.—when stacked in large quantities in a damp state, undergo a process of heating from simple *oxidation* (eremacausis) or fermentation, and after a time some of them may pass into a state of *spontaneous combustion.*

Among these substances, hay and cotton, in a damp state, have been known to ignite without any external source of ignition.

Newly stacked hay, insufficiently dried, becomes after a few days hot in the centre of the stack, and aqueous vapor or steam escapes; this is followed by smoke of a peculiar odor of partially burnt vegetable matter, and, on examining the interior of the stack at this time, the hay will be found of a dark brown color, almost charred. At a still later period a thick smoke will issue, followed by ignition or kindling on exposure to the air.

According to the testimony of shippers and merchants, *raw cotton* stacked in quantities or packed in the hold of a ship, before it is thoroughly dry, undergoes a similar series of changes, and is liable to become ignited by the access of air.

A ship laden with *cotton* is liable to destruction at all times by the careless use of fire—by candles, lucifer matches or the smoking of tobacco. It is scarcely possible in such cases to exclude entirely any of these accidental sources of external ignition; and to assign the accident to spontaneous combustion, because no cause is apparent, is illogical. The materials causing the fire are consumed with the cargo. The person who has been carelessly or unconsciously the cause of the fire makes no statement, and the cause can therefore be only a matter of conjecture.

Cotton impregnated with *oil*, when collected in large quantities, under circumstances favorable for the retention of heat, appears to be liable to spontaneous combustion. The accumulation of cotton waste used in wiping lamps and the oil surfaces of machinery has been said to give rise to spontaneous combustion.

The *admixture of oil*, especially siccative or drying oil, with woody fibre of any kind, is more likely to give rise to heating and combustion than any admixture with water.

The *oil*, besides more rapidly *absorbing oxygen*, is itself highly inflammable at a red heat. Water is not only incombustible, but in a quantity of fifty per cent. renders woody fibre indestructible by fire so long as it remains in the fibres or pores. An instance has occurred where a fire took place in a druggist's shop by reason of a quantity of oil having been spilled on dry saw dust. Vegetables boiled in oil furnish according to M. Chevallier a residue which is liable to spontaneous ignition. In the opinion of this writer all kinds of woolen articles imbued with oil and collected in a heap may inflame spontaneously. Hemp, tow or flax similarly imbued with oil may become heated, and the temperature reach a degree to cause them to ignite spontaneously. In the manufacture of floor cloth and sail cloth, mixtures of this kind are generally made, and the storage of these articles in close chambers favorable to the retention of heat may give rise to accidental combustion.

From some experiments made in Russia it appears that a mixture of any drying oil with lamp-black, in certain proportions, is liable to spotaneous combustion. The proportions most favorable to this were found to be about equal parts of lamp-black and linseed oil.

Accidents are said to have occurred in France in the preparation of a balsam in which olive oil was used with dry vegetable matter.

It is probable that linen and cotton rags, paper, jute and cocoanut fibre imbued with oil might undergo similar changes.

Questions involving points of commercial law necessarily arise in reference to these substances.

Woody fibre imprennated with turpentine, according to the observation of the late Mr. Scanlan, is liable to spontaneous ignition.

It is stated by those who have extensive commercial relations with articles of which woody fibre is the basis, that if the substance is once thoroughly dried, the subsequent addition of water to it may cause it to heat but not to ignite. Spontaneous ignition is observed in certain fibres only in the green state. Saturation with water after drying tends to operate chiefly by causing decay or rotting of the fibre.

The decay or eremacausis of vegetable substances is a decomposition analogous to the putrefaction of azotized bodies, and all putrefying bodies pass into the state of decay when exposed freely to the air, and all decaying matters into that of putrefaction when air is excluded. No absolute distinction can be drawn; the carbon is converted into carbonic acid by oxidation in decay and putrefaction, and a proportionate amount of heat is evolved.

Azotized substances—or those organic matters, whether vegetable or animal, which contain nitrogen—are liable to fermentation; but it is not usual to hear of the heat reaching the kindling point. Damp corn, barley or oats will ferment and become heated.

In these cases there would probably be true fermentation, the gluten in the vegetable juices acting as a ferment. The process of malting is a familiar instance of the fermentation of barley. The wet grain becomes spontaneously heated by exposure to air; carbonic acid and aqueous vapor are given off, and the constituents of the seed undergo certain chemical changes. So far as is known, grain in malting has never acquired a sufficient temperature even to torrify itself, much less to ignite spontaneously.

In freshly cut hay, the vegetable juices contain azotized or nitrogenous principles which, as in grain, may pass through a stage of fermentation. If stacked early in large quantity, this fermentation will notoriously lead to the production of a high temperature, charring and spontaneous ignition on the admission of air. Although commonly treated as similar cases, the chemical conditions are different from those which are met with in dried woodey fibre (such as flax, jute or straw) wetted with water. There is no ferment in these cases—the process is simply one of oxidation, and the heating does not go beyond the temperature of boiling water, even if it reaches this. The spontaneous combustion of vegetable matter, therefore, has frequently been admitted upon insufficient evidence.

There can be no doubt that large heaps of wet leaves undergo a process of heating which has been described as oxidation or rotting, but no one has ever observed this to reach a temperature of actual ignition.

In reference to tobacco leaves, which during manufacture undergo fermentation, Chevallier furnishes an answer to the loose statements regarding spontaneous combustion. When the dried leaves of tobacco are moistened with water, tied in small bundles, and then heaped together, fermentation soon commences in them; oxygen is absorbed, the leaves become warm and emit the peculiar smell of tobacco and snuff. If too high a temperature is avoided, the smell increases and becomes more delicate. No instance, however, is recorded in which spontaneous combustion was thus caused. The temperature which the leaves acquire does not as a general rule exceed 176° F. This, among other facts, tends to show that the spontaneous heating of a substance may take place without necessarily advancing to the very high degree required for its combustion.

Dry wood is supposed to have the property of igniting spontaneously. Deal which has been dried by contact or contiguity with flues or iron pipes carrying hot water or steam at 212, is supposed to be in a condition for readily bursting into flame when air gets access to it. The destruction of the houses of Parliament and numerous fires in public and private buildings have been assigned to this cause. Wood which has decayed, and is then dried in an oven or fire, is as inflammable as a pyrophorus, that-pine or other resinous wood which has been for a long time in contact with bodies having a temperature of from 100° to 300°, should lose all its waters and become highly combustible, like dry flax or jute, is no doubt true. That it should ever acquire the property of taking fire below its igniting temperature in air (1000°) is *unproved and untrue. That it should ever reach this burning temperature spontaneously, and without contact with air, brick or metal heated to* 1000° *or upwards, is a view unsupported by any known facts.*

SPONTANEOUS COMBUSTION OF THE HUMAN BODY.

The hypothesis of the spontaneous combustion of the human body took its origin about one hundred and fifty years ago, at a time when the facts connected with combustion, and the elements upon which it depends had not even been discovered.

It was readily accepted by those who could not in any other way account for the phenomena, and who were either incompetent or unwilling to reason correctly from recorded facts. When this theory arose, all bodies were supposed to hold within them a principle of fire *(phlogiston)*, which might be eleminated from them under certain conditions. When a person was found burnt, and no cause was apparent, the fire was supposed to have a spontaneous origin, i. e., within the body of the deceased.

It does not appear that any one on whose judgments reliance can be placed, has ever seen a case, or recorded the details from actual observation.

The hypothesis of such a mode of destruction of the human body is not only unsupported by any credible facts, but is as wholly inconsistent with all that science has revealed as witchcraft itself.

In the instances reported which are worthy of any credit, *a candle, a fire, or some other ignited body has been at hand, and the* accidental kindling of the clothes of the deceased was highly probable, if not absolutely certain.

It is in vain that they who adopt this hypothesis appeal to the electrical state of the atmosphere or the individual, coupled with the impregnation of the tissues with alcohol, as conditions sufficiently explanatory of their views; *such explanations may be reserved until the occurrence of this spontaneous combustion from external causes is placed beyond any reasonable doubt.*

There is nothing in the structure of the human body which is not equally found in the bodies of all warm-blooded animals. No one has ever ventured to record a case of the death by spontaneous combustion of any domestic animal, for all experience would be adverse to such a statement, and *the cases recorded as having occurred in human beings are either untrue, or are explicable as ordinary natural phenomena—the combustion of clothing or furniture, or the result of accident.*

Some writers who have rejected the doctrine of spontaneous combustion, have taken the view that the human body may in certain cases acquire preturnaturally combustible properties. Although they admit that fire is always applied from without, they at the same time contend that from the amount of animal matter found burnt, compared with the clothing or furniture, which may have become ignited, the flesh, soft organs, and even bones, must have been more combustible than usual. Such a theory as this, however, is not required to explain the facts. Dry animal solids readily burn, but the soft parts, either in the living or recently dead body, contain as much as 72 *per cent. of water, which renders them highly incombustible.*

Until this large proportion of water is evaporated the substance does not undergo combustion.

The presence of fats or even of spirits in flesh does not render it more combustible.

The fact is, the spirits will burn, but the flesh can only be burned by removing from it the substance which interferes with its combustibility—namely, water.

There is not the slightest evidence to show that the parts of the body ever acquire increased combustible properties from disease. The theory, therefore, proposed to be *substituted for spontaneous combustion is wholly unsupported by evidence.*

SPONNANEOUS COMBUSTION OF MINERAL SUBSTANCES.

Although there is an entire failure of evidence to show that the animal body is liable to spontaneous combustion, there is good reason to believe that this phenomenon may occasionally manifest itself in certain organic and mineral substances, and cause destruction of life and property. Under these circumstances a person may be unjustly charged with an act of incendiarism, and the proof of his innocence may depend upon the skill and knowledge of a scientific expert who is required to investigate the case. Evidence on this subject may be demanded in cases of marine insurance, in which it is alleged that ships and cargoes have been destroyed by spontaneous combustion, as when articles of merchandise have been accumulated in a populous neighborhood, and life and property are said to be endangered by their liability to accidents of this nature.

The facts connected with the spontaneous ignition of mineral substances are generally known to, and seldom admit of doubt among scientific men.

The mere exposure of a variety of substances to the air at any temperature is sufficient to cause their combustion almost instantaneously. Phosphorus dissolved in sulphide of carbon furnishes an instance of this kind. If this solution is poured upon paper, so soon as the solvent has evaporated the particles of the phosphorus are left on the paper in a minutely divided state. By their sudden combination with oxygen, sufficient heat is produced to cause inflammation of the phosphorus.

Tartrate of Lead and Prussian Blue, heated in a tube, yields respectively lead and iron in a very finely-divided state.

When the tubes are broken, and the powders are brought into contact with the air, the metals are instantaneously oxidized and burn with a bright light.

These substances are well known as *pyrophori*.

Spontaneous combustion is in these cases, owing to the state of extreme division of the particles of matter, and to the heat produced by instantaneous oxidation over an extensive surface. This heat is sufficient to render the small metalic particles incandescent.

Some substances in the state of vapor or gas, as *phosphide* and *silicide* of *hydrogen*, burn at once with a volume of flame on exposure to the air. The combustible substance is here placed in a state most favorable for sudden ignition at the common temperature of the atmosphere. Ordinary charcoal does not undergo combustion in air until it has been heated to a temperature of from 1000° to 1200° Fahrenheit; but it would appear that in some states it is liable spontaneously to acquire a temperature which may lead to its unexpected combustion.

Liebig asserts that there is no example of carbon alone, even in the finest state of division, combining directly with oxygen at common temperatures, but that numerous facts show that hydrogen in certain states of condensation possesses this property.

Lampblack, which has been heated to redness, may be kept in contact with oxygen gas without forming carbonic acid; but *lampblack impregnated with oils*, which contain a large proportion of hydrogen, gradually becomes warm, and inflames spontaneously.

Liebig assigns the spontaneous inflammability of the charcoal used in the manufacture of gunpowder, to the hydrogen, which it contains in considerable quantity; for during its reduction to powder no trace of carbonic acid can be detected in the air surrounding it. It is not found until the temperature of the atmosphere has reached a red heat, i. e., 980° to 1160°. The heat which produces combustion, therefore, in Liebig's opinion, is not caused by the oxidation of the carbon.

According to M. Aubert, a French engineer, recently made charcoal in a fine state of division is liable to become spontaneously ignited, without reference to admixture with oil.

Coals Containing Pyrites.—There have been many instances of the ignition of coals, as a result of the presence in them of certain kinds of iron-pyrites, and actions for damages to merchandise have been brought.

When water comes in contact with a large heap of coals, containing pyrites, a chemical action takes place, whereby the mass is heated; and if favorably placed for the retention of heat, as in the hold of a ship, the effect may be the heating of the coals to the point of combustion and the destruction of the vessel and cargo.

Sulphur.—Although highly combustible, has no tendency to spontaneous combustion.

Sulphur does not absorb oxygen or combine with it below a temperature of 400°.

The vapor of the sulphide of carbon is more inflammable than the vapors of alcohol, ether and wood spirits, and takes fire at as low a temperature as 300°.

Coal gas, and the vapors of coal oil, alcohol, ether, oil of turpentine and benzole require a full red heat, visible in daylight (1160°), for bursting with flame.

Wood spirits vapor requires for its ignition a red heat, but it is more easily kindled than those above mentioned, and the flame spreads rapidly.

It is necessary here to advert to an error which appears to prevail respecting the vapors of inflammable liquids. It is supposed, because the liquids are highly combustible, that the vapors which they give off at common temperatures, or at a low degree of heat are spontaneously inflammable, or are liable to be inflamed at a very low temperature.

The above mentioned liquids give off

vapors at different temperatures, which are combustible if a flame or visibly red hot metal is brought directly in contact with them, but not otherwise.

In this respect they do not differ from the most inflammable gases, such as hydrogen or coal gas, which are not ignited by a temperature below a visible red heat (1160°), and unless this temperature is reached the vapors and gases do not take fire.

The liquids differ in their volatility. Sulphide of carbon is entirely converted into vapor at 110°; wood spirits, or naptha at 140° to 150°; alcohol at 174°; coal naptha at 176°, and oil of turpentine at 312°; but these liquids evolve a highly inflammable vapor at temperatures below 100°, and this vapor, if accidentally kindled by flame or a red heat, may spread destruction.

Those combustible liquids are safe, which evolve no vapor at common temperatures, but burn only with a wick: eg. colza oil, rectified parafine oil and petroleum, when freed from the highly volatile hydro-carbon vapors, which are generally associated with it.

Vapors may be ignited at a distance from the liquids, and fire will instantaneously spread throughout the mass with explosive violence.

Phosphorus Lucifer Matches.—Phosphorus, when in a dry state, has a great tendency to ignite spontaneously.

As phosphorus undergoes oxidation at all temperatures, when exposed to air, and its igniting point is lower than that of any other solid, there is always danger, unless this substance is kept in water. It will take fire even when the surrounding temperature is as low as 70° F. Its melting point is 113°. At 120° it melts and burns readily.

The ordinary lucifer match composition takes fire at about the same points, 120°. F. During the summer this composition is luminous in the dark, a fact which shows that oxidation is going on, and therefore a process of heating. Hence large quantities of these matches kept in contact may produce a heat sufficient for ignition. Still it is rare to hear of spontaneous combustion from them, and when they become ignited it is probably the result of some mechanical cause. The slightest friction is in some instances sufficient for this purpose.

Mixtures of solids not containing sulphur, are not liable to spontaneous combustion, although they will burn from a slight increase of temperature.

In reference to *gunpowder*, there is no instance recorded in which this substance has spontaneously ignited; the finest gunpowder requires a temperature of 525° for its inflammation and perfect combustion.

Red Fire, an inflammable composition, much used in theatres and pyrotechnics, consists of a mixture of chlorate of potash, charcoal, sulphur, sulphide of antimony and nitrate of strontia. An instance is on record in which a mixture of this character inflamed spontaneously.

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